

2014-2017 BUSINESS PLAN

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Alberta Innovates – Energy and Environment Solutions



**Alberta
Innovates**
Energy and
Environment Solutions

Alberta

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EXECUTIVE SUMMARY

Build a more innovative and competitive Alberta

This means Alberta's research and innovation communities are collaborative, focused, aligned, and adaptable; and that Alberta research and innovation leads to new ideas, products, services, and processes that offer social benefit and enhance Alberta's economic competitiveness.

Innovation and Advanced Education 2014 – 2017 Business Plan

Alberta Innovates – Energy and Environment Solutions (AI-EES) is a part of Alberta Innovates, a collaborative system built on a strong legacy and proven success. As the “... **research, innovation and technology implementation arm of the Government of Alberta ministries in energy and environment**,”¹ AI-EES' focus is to bring together decision makers from government and industry, as well as research and innovation technology organizations, to develop solutions for the key technical challenges facing Alberta's energy, environment and water sectors.

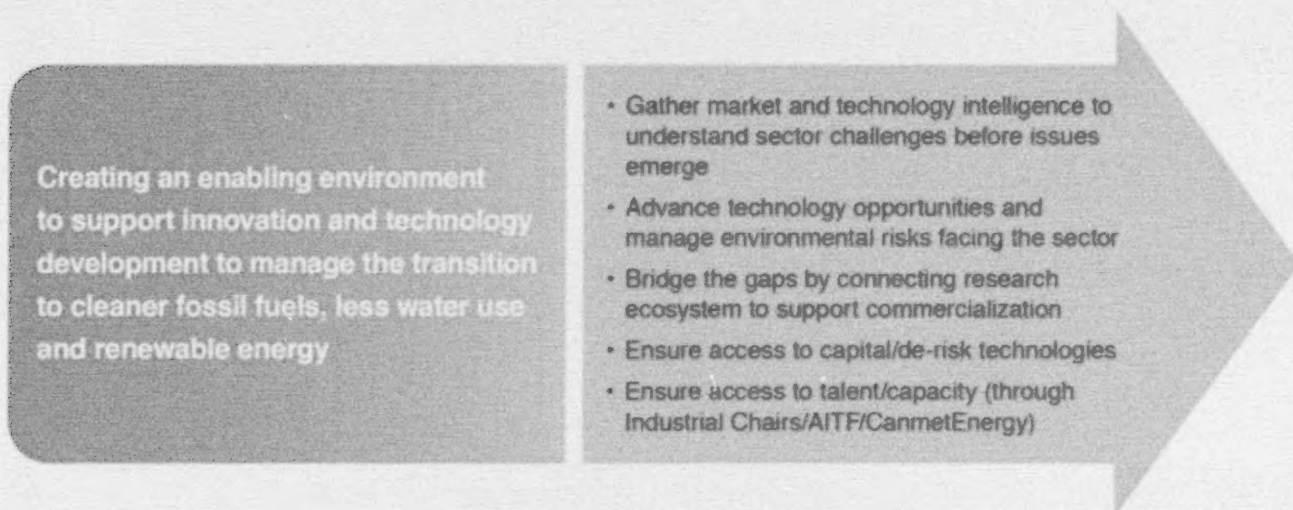


Figure 1: This illustration summarizes how AI-EES is building an innovation support network.

BUSINESS PLANNING CONTEXT

Energy remains vitally important to the Canadian economy, contributing 26 per cent to the country's Gross Domestic Product (GDP)². Realizing the full potential of energy technology, which goes hand in hand with environmental sustainability, can drive GDP and job growth in Alberta. This value can be created through:

- The global export of energy technologies and services
- The sale of energy products enabled by new technologies in resource production

¹ Mandate and Roles Document - http://ai-ees.ca/media/7985/mandate_and_roles_of_ai-ees_100331_final.pdf

² Statistics Canada, Centre for Energy, McKinsey Electric Power and Natural Gas (EPNG) and Sustainability and Resource Productivity.

- An increase in domestic GDP by increasing competitiveness of Canadian industries and lower cost of living through affordable and cleaner energy.

To ensure AI-EES is focused in the areas that promise the greatest opportunity for Alberta, it's important to consider the global energy outlook for 2030³:

- Fossil fuels remain important as an energy source
- Renewables are a small, but increasingly important
- Demand for energy is driven by a new middle class, but offset partly by efficient technologies
- Environmental factors will increasingly constrain resource production.

AI-EES is uniquely positioned to swiftly address Alberta's key challenges:

- Adoption of technology focused on recovery efficiency and increasing the value of oil and gas products, and advancing the uptake of renewable energy
- The safe transport of energy products to markets
- Obtaining the most value for Alberta's stranded natural gas resources that have lost market share
- Competition from shale and tight oil resources and the need to align Alberta's oil sands products to better match refinery specifications
- Reducing the impacts of energy development on Alberta's ecological resources, including air, land and water
- Accelerating tailings reclamation
- Energy storage solutions to make renewables more viable.

MAJOR BUSINESS STRATEGY FOR 2014-17

To most efficiently address Alberta's key challenges, AI-EES has adapted its Major Business Strategy for 2014-2017. AI-EES' portfolio already includes commercialization opportunities in energy storage, bioenergy, carbon capture and especially water treatment. The changing energy and environment landscape globally, and in Alberta, however, presents the ideal opportunity to further develop AI-EES' Advancing Clean Energy Commercialization business model (Figure 3: Page 13). The implementation of this model will make AI-EES and Alberta's innovation system better able to respond to market opportunities and will lead to greater commercialization of technologies.

To further support our business plan, AI-EES signed an Interchange Agreement with NRCan's CanmetENERGY, the Canadian leader in clean energy research and technology development. Through this Agreement, AI-EES will work towards greater synergy between Federal and Provincial research and technology in sustainable unconventional resource development and water and renewable energy (including electricity). This Agreement is an excellent example of the possibilities for alignment of innovation, research and commercialization and builds on the Alberta - Canada Collaboratory in Cleaner Oil Sands Development

³ McKinsey Global Energy Perspective Model, McKinsey Resource Revolutions Report, McKinsey EPNG and SRP Practices.

Memorandum of Understanding (MOU) announced in February, 2012 by Premier Redford and Minister Oliver. As well, the Agreement builds on the history of collaboration in oil sands heavy oil research and work done by the National Centre for Upgrading Technology, which was created in May 1995, as a research program co-managed by the Governments of Canada and Alberta.

AI-EES' tight focus on energy and the environment can continue to deliver tangible outcomes for Alberta financially and ethically because our work underpins the tenets of Alberta's societal values for environmental performance and economic well-being.

RESEARCH AND INNOVATION PRIORITIES

Taking bold and accelerated actions to position Alberta to achieve superior environmental performance while growing and diversifying the energy economy is our top priority. By providing strong leadership AI-EES will decisively implement the Government of Alberta's vision in its three theme areas of Energy Technologies, Renewable and Emerging Technologies and Water and Environmental Management.

ENERGY TECHNOLOGIES INITIATIVES:

1. Pilot(s) advancing lower carbon intensive bitumen recovery technologies using steam, electromagnetic heating and solvents in sandstone and carbonate reservoirs
2. Field upgrading demonstration having high yields and reducing the need for diluents
3. Investigation of non-aqueous extraction methods for oil sands
4. Investigation of value added opportunities and technology adaptation for natural gas.

RENEWABLES AND EMERGING TECHNOLOGIES INITIATIVES:

1. Reduce landfills by supporting a vibrant waste utilization industry
2. Development of energy storage technologies to support widespread deployment of renewable electricity
3. Development of Technology Intelligence Mapping System to identify the most promising technologies, assessing their competitive advantage and technology readiness with the goal of accelerating the development and deployment of novel technologies.

WATER AND ENVIRONMENTAL MANAGEMENT INITIATIVES:

1. Build projects to enhance scientific understanding and develop best practices in managing water security, risk and vulnerability, and watershed stewardship and ecosystem management.
2. Screen, field test and demonstrate advanced technologies to speed up tailings reclamation
3. Enhance scientific understanding and develop best practices in managing atmospheric deposition, wetlands, land disturbance, ecosystem health, biodiversity conservation, environmental monitoring, and restoration ecology.
4. Develop, pilot, and demonstrate advanced carbon capture, fugitive emission reduction, and energy efficiency technologies.

Vision

Alberta leads the world in developing innovative energy and environmental technologies building on our natural advantages to achieve a socially acceptable, diversified and prosperous economy.

Mission

To increase Alberta's capacity to develop, adapt and commercialize innovative technologies that maximize the value of the province's natural and renewable resources while protecting the environment.

STRATEGIC APPROACH

EES achieves its mission by:

- Promoting collaborative research and development along the entire innovation chain, in partnership with industry and other funding organizations
- Working closely with the Alberta Innovates corporations and government departments to strengthen the province's energy and environmental sectors
- Taking a strategic view that links knowledge and needs, and acquires, advances and integrates the knowledge vital to maintaining Alberta's global leadership in energy and the environment.

Values

Our values serve as the foundation to guide how we work together and for our province. These values exemplify our organization's culture and its people.

Innovative: We see opportunities where others see issues. Breaking down barriers to develop solutions for the biggest issues facing the energy and environment sectors is what we do best.

Entrepreneurial: We gather and tap into market intelligence that keeps us ahead of the curve. To innovate, you must be able to *recognize* innovation. Fast on our feet, we find the *partners* and *resources* to capitalize on all the possibilities for a clean energy future.

Leaders: With the clean energy and environmental goals for our province top of mind, we have the courage it takes to foster game-changing innovation.

Collaborative: It's about moving beyond your own ideas to see the broadest view. We work to build a sense of community, bridging the gap between organizations and ideas. As a catalyst for making connections and forging partnerships – in the province and internationally -- we are able to bring the right people, organizations and policy makers together to change the game for Alberta.

Trusting and Trustworthy: Working with integrity, we *strive* to do the right thing and are accountable for outcomes.

Respectful: Debate leads to good decisions and we believe everyone contributes to a discussion. Treating one another with the respect and dignity, giving individuals a chance to learn and grow and savoring unique voices, matters and makes a difference.

Mandate

The Mandate and Roles Document for Alberta Innovates – Energy and Environment Solutions (“AI-EES”) has been developed collaboratively between the Minister of Innovation and Advanced Education and AI-EES to reflect a common understanding of roles and responsibilities.⁴ The mandate given to AI-EES states that:

AI-EES will serve as the research, innovation and technology implementation arm for Government of Alberta ministries in energy and environment, applying world-class research and innovation management strategies to preserve and enhance Alberta’s economic, environmental and social well-being.

The Government of Alberta has given AI-EES the following responsibilities as set forth in the *Alberta Research and Innovation Regulation*:

- To support, for the economic and social well-being of Albertans, energy and environment research and innovation activities aligned to meet Government of Alberta priorities, including, without limitation, activities directed at the development and growth of the energy and environment sectors, the discovery of new knowledge and the application of that knowledge.

As a key player in the innovation network, AI-EES will create value through:

- Increased effectiveness and integration of planning, funding and delivery of research and innovation programs
- Alignment of programs and investments toward priority areas and outcomes
- Improved facilitation of knowledge, intellectual property, technology and skill transfer within the system, and between academia, industry and government
- Improved accountability and outcomes through integrated performance monitoring and continuous improvement processes
- An integrated and disciplined research and innovation process to inform government policy and regulations for sustainable development.

AI-EES has developed the following principles to guide our investments:

- Secure maximum value from Alberta’s energy resources, including reducing the global vs. Alberta price differential
- Provide science-based information to inform policy
- Strengthen the innovation capacity to support Alberta’s energy and environmental priorities
- Improve environmental performance, including water resources sustainability
- Advancing technology readiness
- Increase deployment of clean energy
- Transfer technology to the appropriate sectors.

⁴ http://ai-ees.ca/media/7985/mandate_and_roles_of_ai-ees_100331_final.pdf

COMPETITIVE CONTEXT

To determine our corporate priorities, it is important to understand the environment, trends, risks, challenges and opportunities facing the energy and environment sectors and how those have evolved over the past year.

INNOVATION IN AN UNCERTAIN ENVIRONMENT

Our **core business** is to position Alberta to achieve superior environmental performance while growing and diversifying the energy economy. This will ensure that Alberta continues to lead the country in exports, job growth and wealth generation. Energy remains vitally important to the Canadian economy, contributing 26 per cent to the country's Gross Domestic Product (GDP)⁵. Based on the experience of other jurisdictions, realizing the full potential of energy technology, which goes hand in hand with environmental sustainability, can drive GDP and job growth. This value can be created through:

- The global export of energy technologies and services
- Incremental sales of energy products enabled by new technologies
- An increase in GDP by increasing competitiveness of Canadian industries or lower cost of living through cheaper, cleaner energy.

There are a number of unique characteristics and challenges related to the development of energy and environment technologies:

- Projects require high capital investments (multi-billion \$ for major plants) and require long term payouts (10 – 20 years)
- These investments are high risk and subject to: energy price volatility; shifts in supply and demand; policy uncertainty, environmental risks and challenges to social license to operate
- The sector is multi-faceted and complex: technologies develop from many basic science areas; and the sector encompasses many disparate industries, companies and stakeholders.

2030 Global Outlook

To ensure AI-EES is focused in the areas that promise the greatest opportunity for Alberta, it's important to consider the global energy outlook for 2030⁶.

Fossil fuels remain important as an energy source through 2030:

- New technology development allows access to previously inaccessible unconventional resources (e.g. oil sands in Canada, shale gas in US)
- Coal remains an important resource in Asia.

⁵ Statistics Canada, Centre for Energy, McKinsey Electric Power and Natural Gas (EPNG) and Sustainability and Resource Productivity.

⁶ McKinsey Global Energy Perspective Model, McKinsey Resource Revolutions Report, McKinsey EPNG and SRP Practices.

Renewables are a small, but increasingly important power source by 2030:

- Technologies are maturing and coming down the cost curve quickly, making them competitive in select geographies (e.g., solar for peak generation in sunny climates, wind for offshore areas and islands)
- While installed base is mostly fossil fuels, forward capital expenditure (capex) growth is heavily renewables
- Adoption is also driven by emissions related targets and anticipation of increased regulations
- Adoption in Canada of new renewable technologies for electricity (solar, wind, biomass) will be slower than other countries due to existing hydro, natural gas and nuclear power generation capacity.

Energy demand is driven by a new middle class in developing countries, but is offset partly by efficient technologies:

- Emergence of 3 billion middle class in Asia driving increased demand for cars, buildings and other consumers products
- Demand increase is partly offset by stricter fuel efficiency standards (which in turn has driven innovation in fuel-efficient transportation), increase in biofuel use, development of hybrid and electric vehicles, causing a significant decrease in fuel demand in Canada and U.S.
- Demand is also reduced by development and adoption of energy efficient technologies for both buildings and industrials, particularly in developed economies.

Environmental factors will increasingly constrain resource production:

- Resource companies will need to more actively monitor and improve their effect on the environment to mitigate against reputation risk
- Biodiversity loss associated with resource production will increasingly have economic implications
- Stress on freshwater resources and productive land will increase creating conflicts with resource production.

Key Provincial Challenges

The province is affected by global economic uncertainty and unprecedented risks due to commodity volatility and market access. This challenge is exacerbated by a fast-growing environmental consciousness and push toward clean energy, clean water and sustainable development. Figure 2 illustrates the market challenges that Alberta faces due to growing competitive energy supplies, access to refineries and declining demand for transportation fuels.

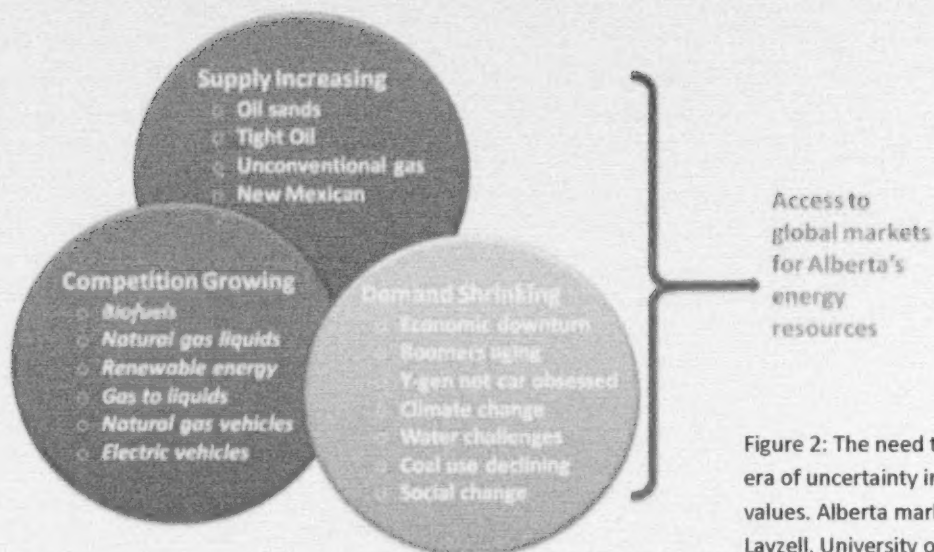


Figure 2: The need to grow innovation capacity in an era of uncertainty in markets and changing societal values. Alberta market challenges: adapted from David Layzell, University of Calgary.

Addressing challenges

As a technology organization our focus is on innovation -- to scrutinize market intelligence while putting science and engineering to work to address the desired societal outcomes including:

Economic Impact: value added, market access, diversification, accelerating commercialization

Environmental Performance: emissions, water use, land and biodiversity

Innovation Capacity: science informing policy, research intensive organizations, industrial knowledge transfer.

The following is a summary of the priorities AI-EES will address in the 2014 - 2017 planning cycle:

AI-EES – UNIQUELY POSITIONED TO SWIFTLY ADDRESS KEY CHALLENGES

TECHNOLOGY ADOPTION	Issue: There is a need for increased efficiency of producing oil and gas and adoption of renewables that will lead to reduced greenhouse gas emissions. Solution: AI-EES is working with industry to identify and de-risk technologies to produce and process our resources to higher value; advance the use of carbon capture; promote waste to biofuels technologies; and advance energy efficiency.
MARKET ACCESS	Issue: Our economy is export driven and dependent on pipelines and rail systems to transport energy products. Solution: AI-EES is working to ensure the safe transport of oil sands derived crudes to traditional and emerging markets and revolutionizing the approach to spill handling on land and waterways and GHG reductions.
ABUNDANT UNCONVENTIONAL GAS RESOURCES AND TIGHT OIL	Issue: Development of U.S. unconventional gas resources has led to the loss of gas markets resulting in a major negative impact on Alberta's natural gas industry and Government royalties. Solution: AI-EES is pursuing government-industry partnerships to obtain higher value for Alberta's stranded and flared/vented natural gas resources (e.g., novel modular gas-to-liquids systems).
COMPETITION FROM SHALE AND TIGHT OIL RESOURCES	Issue: 'Fracking' has made shale oil and tight oil production economic and made the U.S. the largest oil producer in the world. Competition for pipeline and refinery space has exacerbated market access and has curtailed fair market value for oil sands derived crudes. Solution: AI-EES is working with industry to understand the needs of refineries on three continents (Asia, North America and Europe) and targeting product quality formulations that better match refinery specifications, provide higher value, and allow for greater volumes to be transported in pipelines.
LAND MANAGEMENT/ WATER	Issue: The cumulative effects of resource development has resulted in multiple impacts on valuable ecological services provided by Alberta's land and water. Solution: AI-EES is working with partners and other organizations to swiftly reduce impacts of energy development. Priorities include: improved water use, tailings management, integrated resource management, biodiversity conservation and landscape restoration.
ENERGY STORAGE	Issue: a substantive effort on Energy Storage will make renewables more viable and reduce the carbon intensity of the electric system. Solution: AI-EES is investing in cost effective energy storage technologies that will allow use of more wind, biofuels and renewable energy sources.
SOCIAL LICENSE	Issue: Alberta remains a target for "dirty oil" Solution: AI-EES provides technical information to correct misinformation in the public realm. We provide accurate information based on science in search of fair, balanced and accurate coverage that can aid public education efforts.

SEIZING OPPORTUNITIES AND ACCELERATING INNOVATION

The changing energy and environment landscape provides the ideal opportunity to further develop AI-EES' Advancing Clean Energy Commercialization business model (See Figure 3) which is the major business strategy for 2014-17. Traditionally, AI-EES and its predecessors (AERI and AOSTRA) partnered with asset owners who had the capacity to directly commercialize technology. Today, the Corporation's portfolio includes potential commercialization opportunities of early stage research and development with small and medium enterprises in energy storage, bioenergy, carbon capture and especially water treatment. The emergence of private equity and venture capital in Alberta provides the perfect springboard and AI-EES is leveraging this opportunity through a formal development partnership with Fronterra Ventures and informal partnerships with other venture capital firms.

Advancing Clean Energy Commercialization

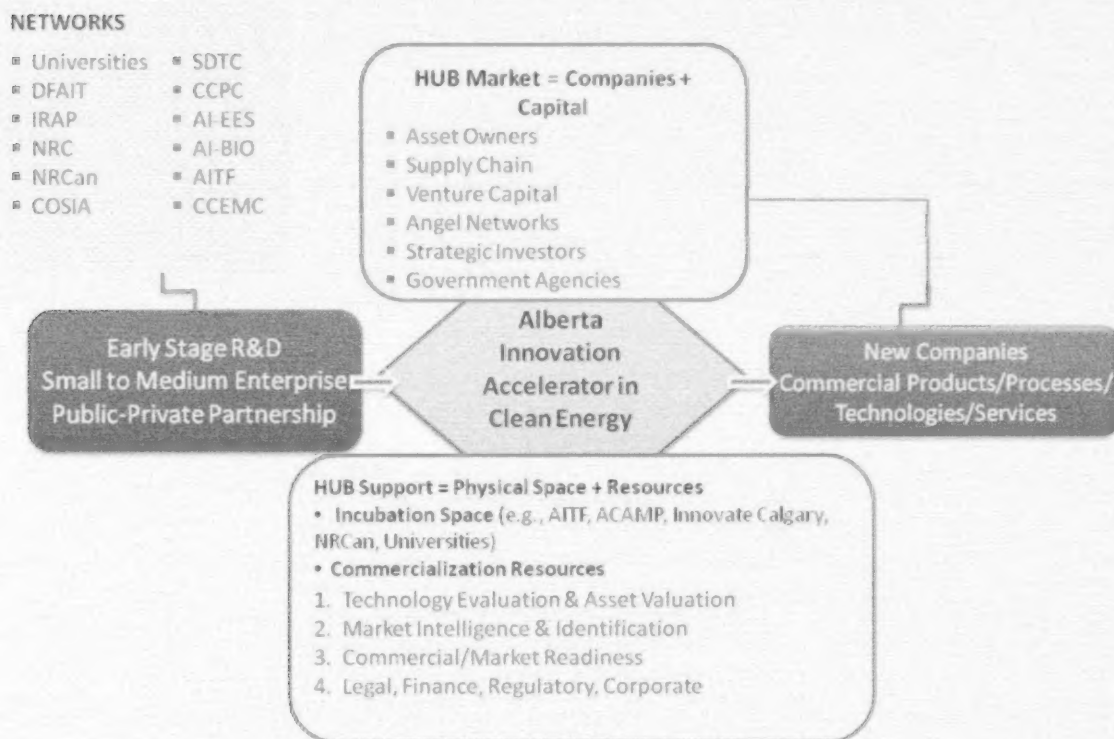


Figure 3: This model illustrates how AI-EES (with the ecosystem) is advancing clean energy commercialization. This business model was co-imagined by Fronterra Ventures and AI-EES.

AI-EES is an entrepreneurial organization that has developed the requisite trust and credibility of working in partnerships with industry and government in resource development and environmental protection to

advance the province's vision. Our relationships and track record in innovation position AI-EES to further a unique collaboration between private capital, technical expertise, project funding/support and external expertise to achieve innovation and diversification in Alberta's energy and environment sectors. Building a community of ecosystem partners to accelerate access to capital, deal flow and commercialization resources is an activity that we have been advancing since our Corporation's inception in January, 2010.

Networks/Developing market and technology intelligence: AI-EES gathers market intelligence and 'scouts' for technologies internationally to identify opportunities that advance Alberta's competitive position. Working with industry, academia and international collaborators, AI-EES identifies and designs a fit-for-purpose research and technology approach to help the province meet its goals to seek the highest value for our natural resources, reduce GHG emissions and conserve precious water resources.

Support R&D to marketplace: Most AI-EES projects involve industry partners. AI-EES staff work with industry to develop ideas for research and innovation projects and co-funding opportunities. AI-EES Board members have significant industry and business experience and provide strategic leadership and oversight. Board members and staff are often called upon by provincial, national and international organizations to provide advice and are in a position to influence industry and government directions in research and technology.

STRATEGIC COLLABORATION

AI-EES has a unique history and culture inherited from its predecessor organizations, AOSTRA, AERI and AWRI. AI-EES is built on the fundamentals of independent thinking and relies upon networking and a collaborative approach that supports Alberta government priorities. The staff are technically experienced in the program areas of AI-EES and have the required core competencies of identifying, evaluating and selecting technologies and partners for initiatives that position Alberta for the future in energy and environment. AI-EES' staff are in demand by the Climate Change & Emissions Management Corporation (CCEMC), Alberta Government Ministries, Natural Resources Canada and the Canadian Oil sands Innovation Alliance (COSIA), who look to the AI-EES team to provide technical validation of third-party technology to advance projects in the government and industries' interests.

AI-EES has also developed the management and evaluation tools, including engaging consulting engineering companies, to enable the Corporation to make rational decisions on how it deploys its internal resources and selects initiatives.

ALIGNMENT

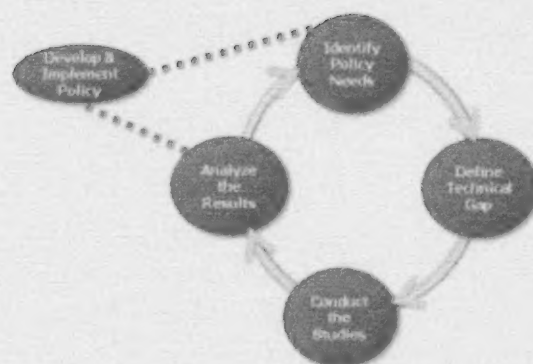
Alignment with the Government of Alberta

In 2010, AI-EES signed a Technology Informing Policy MOU with the Alberta Energy, Alberta Environment, Alberta Sustainable Resource Development (now ESRD) and Finance and Enterprise (now Innovation and Advanced Education). This MOU, which has already resulted in some 30 initiatives, provides the GOA with support in developing policy and strategic planning excellence.

Figure 4: Outlines the Technology informing policy process co-imagined by AI-EES and four Government of Alberta Departments in 2010.

Research & technology to support GoA policy and strategic planning excellence

- Technology informing policy (TIP) – MOU signed with ADOE, AENV, SRD and F&E (September 2010)



Also, AI-EES staff meets regularly with GOA counterparts to discuss specific issues and opportunities involving energy and environment research and innovation and to develop projects that will benefit all parties. AI-EES has a strong track record of working with other departments on several initiatives, including Phase I Competitiveness Study, Mitigation of Dilbit Spills, Gas to Liquids Study, Carbon Capture and Storage, Advanced Recovery Pilots, Bitumen Royalty In Kind, Life Cycle Analysis and ecoTrust.

AI-EES relies on the following relevant government strategies for planning purposes:

- *Alberta Research and Innovation Plan*, updated annually
- *Provincial Energy Strategy*
- *Renewed Water for Life Strategy*
- *Tailings Management Framework* (in development)
- *Land Reclamation Framework* (in development)
- *Responsible Actions: A Plan for Alberta's Oil Sands*
- *Climate Change Strategy* (AI-EES is involved in current review process)
- *Land-use Framework*
- *Alberta Nanotechnology Strategy*
- *Directive 074 – Tailings Performance Criteria and Requirements for Oil Sands Mining Scheme*
- *Shaping the Future*, Report of the Premier's Council for Economic Strategy.

CAPACITY BUILDING

Federal government alignment

In 2014, AI-EES signed an Interchange Agreement with NRCan's CanmetENERGY, the Canadian leader in clean energy research and technology development. Through this Agreement, AI-EES will establish greater synergy between Federal and Provincial research and technology in sustainable unconventional resource development and water and renewable energy (including electricity). This Agreement is an excellent example of the possibilities for alignment of innovation, research and commercialization and builds on the Alberta - Canada

Collaboratory in Cleaner Oil Sands Development announced in February, 2012 by Premier Redford and Minister Oliver. As well, the agreement builds on the history of collaboration in oil sands and heavy oil research and work done by the National Centre for Upgrading Technology, which was created in May 1995, as a research program co-managed by the Governments of Canada and Alberta.

The CanmetENERGY lab at Devon focuses on the development of cleaner fossil fuels and related environmental technologies with a focus on oil sands and heavy oil and has forged strong partnerships with stakeholders across the innovation spectrum, including our province, the Province of Saskatchewan, industry, research organizations world-wide and universities across Canada.

The alignment of these programs will lead to multiple benefits for Governments and industry on innovation and sustainable resource development

Building research capacity at universities connected to pilots and pre-commercial demonstration

AI-EES has focussed its efforts on partnering with industry and post-secondary educational institutions and industry and has built an impressive portfolio to support next generation technologies and environmental sustainability, which will contribute to the province's economic, environmental and social outcomes:

▪ Managing Industrial Research Chairs in the following areas:

- Petroleum thermodynamics
- Oil sands engineering
- Bitumen upgrading
- Reservoir simulation
- Unconventional gas
- Water quality management
- Tailings water treatment
- Energy and environmental systems engineering
- Petroleum microbiology
- Reservoir geomechanics
- Biodiversity conservation
- Oil sands tailings geotechnique.

▪ Providing technical advice/directions to four R&D Centres:

- Alberta Helmholtz Initiative
- Carbon Management Canada
- Centre for Oil Sands Innovation
- Centre for Clean Coal/Carbon and Mineral Processing Technologies.

Working alongside Alberta Innovates – Technology Futures (AITF):

For over 40 years, AI-EES and its predecessors AERI and AOSTRA, have been the main investors in the Alberta Research Council (now the ARC division of AITF). In 2012, AI-EES initiated projects at AITF in areas ranging from geological sequestration to pipeline management to battery storage:

- Comparison of the corrosivity, flammability and spill response of dilbit and conventional crudes

- Removal of organics from oil sands tailings: disposition and processability
- Advanced air LiDAR
- Predictive eco-site classification platform for technology development and piloting
- Geothermal applications in Alberta
- CO₂ capture
- Weathering of dilbit.

AI-EES supports the AACI Program focused on in situ recovery from heavy oil and oil sands, which has been in operation for 30 years. Though the AITF, ARC and AACI relationships are important to AI-EES, its arms-length operation is critical as this provides AI-EES with an “oversight” role, which is key when ensuring research projects stay focused on very specific challenges and solutions. We intend to continue to work with AITF, as they can provide commercialization supports to SME’s, including incubation space and laboratory services.

PARTNERSHIPS

Climate Change and Emissions Management Corporation (CCEMC)

AI-EES provides strategic advice, technology adjudication and project management for the Climate Change and Emissions Management Corporation (CCEMC). As a member of the operations management committee, AI-EES is also involved in CCEMC's management and strategic planning. In many cases, AI-EES has provided funding and strategic technical counsel to advance early project work, and then projects apply to CCEMC for the funds needed for larger scale pilots. This ensures that AI-EES, CCEMC and government are well aligned in technology demonstration.

Canadian Oil Sands Innovation Alliance (COSIA)

COSIA was launched two years ago as an alliance of oil sands producers focused on accelerating the pace of environmental performance in Canada's oil sands. AI-EES initiated collaboration with COSIA in developing and publically releasing the Tailings Technology Roadmap and Action Plan. The collaboration also involved Alberta Energy, Natural Resources Canada, Alberta Environment & Sustainable Resource Development and the Alberta Energy Regulator. Since that time AI-EES and COSIA have collaborated on several projects. Below is a listing of the currently active projects:

- Industrial Research Chairs in Biodiversity and Conservation
- Restoring historic linear disturbances
- Aurora soil – capping study
- Natural and anthropogenic influences to groundwater and surface water environments in the Lower Athabasca Region
- Development of a high efficiency mechanical vapor compression evaporator for SAGD application
- In-line dewatering of oil sands tailings
- Bitumen recovery from oil sands tailings: Disposition processability
- Electro-kinetic reclamation technology commercial scale-up testing
- Screening, evaluation and validation of chemicals for oil sands fluid tailings consolidation

- Industrial Research Chair in Oil Sands Tailings Geotechnique
- Secondary MFT technology options.

Partnering with Alberta Innovates – Bio Solutions (AI-Bio)

AI-EES and AI-Bio work closely together in the areas of bioenergy, reclamation and sustainability involving biological systems. AI-Bio expertise in biological conversion such as fermentation complements AI-EES expertise in thermo-mechanical conversion such as gasification and combustion. AI-EES and AI-Bio have established a formal protocol that identifies the working relationship and ensures full alignment between the two Corporations. Examples of joint initiatives include:

- Nutrient status and retention in reconstructed sandy soils for reclamation
- Industrial Research Chairs in Biodiversity and Conservation
- Industrial Research Chair in Systems Engineering
- Integrated source water management in Alberta
- Creating a predictive eco-site classification platform for Alberta.

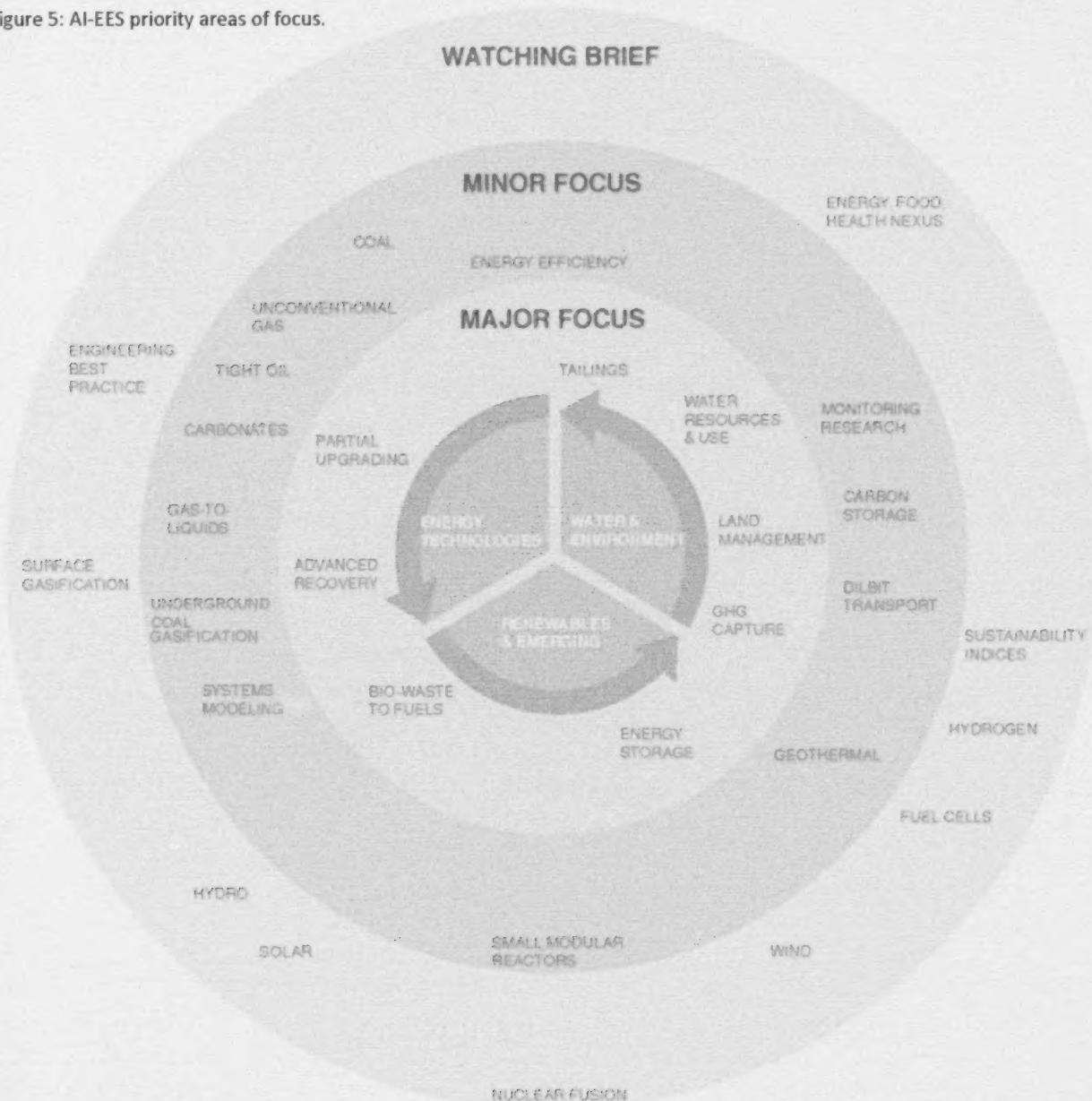
Networks/Industrial Associations and Non-Government Organizations (NGOs):

AI-EES is a member of a variety of industry associations⁷ and provides advice through its membership on boards. Staff members regularly interact with their peers in a variety of meetings, technology workshops and conferences, providing sector insight as well as market and technology intelligence. These interactions assist AI-EES to catalyze research and development opportunities with industry.

⁷ Examples include Alberta Chamber of Resources, Petroleum Technology Alliance of Canada, Carbon Management Canada and Alberta Water Council

AI-EES has a long history of success as a catalyst to convert Alberta's natural resources into market-ready, environmentally responsible energy. Figure 5 illustrates the many competitive opportunities for Alberta. The AI-EES team has considered all opportunities and identified its Major Focus areas. This is the area where our organization sees the greatest potential and is investing most heavily to help Alberta to gain a competitive advantage and enhanced social license. The Minor Focus area outlines project areas and programs we are still supporting and the Watching Brief area shows where we are gathering market intelligence, and not yet in pursuit of projects or programs.

Figure 5: AI-EES priority areas of focus.



ALIGNMENT OF GOALS, OUTCOMES, PERFORMANCE MEASURES AND RESEARCH AND INNOVATION INITIATIVES

HOW AI-EES SUPPORTS THE GOA THEMES

GoA Themes	Investing in families and communities	Advancing world-leading resource stewardship	Securing Alberta's economic future
Triple Bottom Line	Social	Environment	Economic
Alberta's Key Outcomes	Resilient Healthy Communities	Effective Resource and Environmental Management	Broadened Economic Base
AI-EES Core business	Positioning Alberta to achieve superior environmental performance while growing and diversifying the energy economy.		
AI-EES Strategic Areas (Bars indicate relevance to the three tenets of the GoA Vision)			

AI-EES is well-aligned with the Government of Alberta Themes of Investing in families and communities; Advancing world-leading resource stewardship; and Securing Alberta's economic future. To support these Themes, AI-EES works in three strategic areas. Our research and innovation initiatives are shown below, with their corresponding objectives, 2030 targets, performance indicators⁸, and examples of flagship initiatives that are being pursued and will become fully active in 2014-17. Due to the high integration between our strategic areas, some of the 2030 targets appear in more than one area.

ENERGY TECHNOLOGIES OBJECTIVES: 1) LOWER CARBON AND WATER USE IN DEVELOPMENT OF NON-RENEWABLE HYDROCARBON RESOURCES 2) INCREASE MARKET VALUE AND PRODUCT DIVERSITY FOR ALBERTA'S HYDROCARBONS

2030 Targets

- 50 per cent reduction of GHG emissions on a per equivalent barrel basis
- Coal-fired power plants in Alberta at a natural gas equivalent

⁸ The development of specific performance measures was introduced in 2013. In 2014, Performance Measures and Metrics were adapted to align to Government of Alberta Business Plans for the Department of Energy, Environment and Sustainable Resource Development, and Innovation and Advanced Education. These specific outcomes are aligned to AI-EES research priorities in the areas of Energy Technologies, Renewables and Emerging Technologies, and Water and Environmental Management.

- 20 per cent of in situ bitumen production is partially upgraded
- At least 3.5 million barrels per day of heavy oil and bitumen production
- 20 per cent increase in conventional oil production
- 15 per cent of gas will come from non-conventional sources
- At least one modular gas-to-liquid plant.

Performance Measures	2011 Actual	2013-14 Target	2014-15 Target	2015-16 Target
Alberta's oil sands supply share of global oil consumption	2.1% (2012)		2.3%	2.4%
Performance Indicators	2009 Actual	2010 Actual	2011 Actual	2012 Actual
Alberta's total crude bitumen production (thousands of barrels per day)	1,489.5	1,613.4	1,744.6	1,921.7
Conventional crude oil and equivalent annual production (thousands of barrels per day)	589.0	581.9	609.3	672.0
Total marketable natural gas annual production (billion cubic feet per day)	11.48	10.85	10.38	9.8
Upstream oil and gas industry investments in Alberta ¹ : • Total conventional and non-conventional oil and gas extraction investments (\$ billions)	21.6	35.6	44.6	N/A

(Source: Alberta Energy 2014-17 Business Plan)

Initiatives:

1. Pilot(s) advancing lower carbon intensive bitumen recovery technologies using steam, electromagnetic heating and solvents in sandstone and carbonate reservoirs
2. Field upgrading demonstration having high yields and reducing the need for diluents
3. Investigation of non-aqueous extraction methods for oil sands
4. Investigation of value added opportunities and technology adaptation for natural gas.

RENEWABLES AND EMERGING TECHNOLOGIES OBJECTIVE: SUPPORT THE TRANSITION TO LOWER CARBON ELECTRICITY AND FUELS AND PURSUE EMERGING TECHNOLOGY OPPORTUNITIES

2030 Targets

- 50 per cent reduction of GHG emissions on a per equivalent barrel basis
- 20 per cent of energy is derived from renewable resources
- 15 per cent of gas will come from non-conventional sources.

Performance Measures	2012-13 Actual	2013-14 Target	2014-15 Target	2015-16 Target
Municipal solid waste to landfills: Kilograms of municipal solid waste per capita disposed of in landfills	691 (2012)		637	623

(Source: Alberta Environment and Sustainable Resource Development 2014-17 Business Plan)

Performance Indicator	2009 Actual	2010 Actual	2011 Actual	2012 Actual
Alternate and renewable generation capacity in Alberta (megawatts) ¹	5,369	5,678	5,805	6,461

¹ A&R generation capacity includes wind, hydro, biomass, and natural gas cogeneration technologies.

(Source: Alberta Energy 2014-17 Business Plan)

Initiatives:

1. Support the development of a vibrant waste utilization industry that contributes to Alberta's supply of renewable energy and economic diversity through the production of bioenergy and novel value-added products
2. Support the development of energy storage technologies that will result in cost-effective energy storage and widespread deployment of renewable electricity
3. Develop a Technology Intelligence Mapping System to assist stakeholders in identifying the most promising technologies, assessing their competitive advantage and technology readiness with the goal of accelerating the development and deployment of novel technologies.

WATER AND ENVIRONMENTAL MANAGEMENT OBJECTIVE: TO MEET AND EXCEED INTERNATIONALLY RECOGNIZED ENVIRONMENTAL SUSTAINABILITY MEASURES IN WATER, LAND, AIR AND GREENHOUSE GAS, AND BIODIVERSITY MANAGEMENT

2030 Targets

- 30 per cent increase in water efficiency
- 50 per cent reduction of GHG emissions on a per equivalent barrel basis
- 20 per cent reduction in energy consumed in the production of bitumen
- 100 million m³ reduction from legacy mature fine tailings
- 20 per cent of energy is derived from renewable resources.

Performance Measures	2012-13 Actual	2013-14 Target	2014-15 Target	2015-16 Target
Total greenhouse gas emissions: Success in meeting the total greenhouse gas emissions growth targets measured in million tonnes of CO₂ equivalent, as outlined in Alberta's 2008 Climate Strategy	242 (2011)		246	251
Performance Indicator	Actual (Year)	Actual (Year)	Actual (Year)	Actual (Year)
Drinking water quality index: Percentage of facilities with no significant drinking water incidents	95% (2009)	96% (2010)	96% (2011)	94% (2012)
River quality index (systems had good to excellent water quality): Water quality of six major Alberta river systems at key sites, based on data of four groups of variables (metals, bacteria, nutrients and pesticides), which are averaged to provide an overall water quality rating	6/6 (2008-09)	5/6 (2009-10)	5/6 (2010-11)	4/6 (2011-12)
River systems had good to excellent water quality				

(Source: Alberta Environment and Sustainable Resource Development 2014-17 Business Plan)

Initiatives:

1. Build a portfolio of projects to enhance the scientific understanding and develop the best practices in managing water security, risk and vulnerability, and watershed stewardship and ecosystem management. Develop energy efficient treatment technologies for increased water conservation, efficiency and productivity in energy industry.

2. Screen new, field test and demonstrate advanced technologies to reduce mature fine tailings, enhance progressive reclamation; develop technologies to treat tailings water for safe release.
3. Build a portfolio of projects to enhance the scientific understanding and develop the best practices in managing atmospheric deposition, wetlands, land disturbance, ecosystem health, biodiversity conservation, environmental monitoring, and restoration ecology.
4. Develop, pilot, and demonstrate advanced carbon capture, fugitive emission reduction, and energy efficiency technologies.

OVERALL ACHIEVEMENT OF LONG TERM TARGETS - BUSINESS TRACKING

Our vision is that Alberta leads the world in developing innovative energy and environmental technologies building on our natural advantages to achieve a socially acceptable, diversified and prosperous economy.

AI-EES uses the ProGrid® methodology and Technology Readiness Levels (TRL) to measure overall progress towards the 2030 targets outlined on page 20.

ProGrid Corporate Performance Assessment

Progress within each strategic area is measured annually against a set of criteria that have been developed to quantify progress to our 2020 and 2030 targets. At March 31, 2013, the Performance Grid below shows we had made operational progress (e.g., management capacity was enhanced, new partnerships were developed and new funds led to greater investments in priority areas). As our innovation capacity improves we expect to see greater environment and economic impacts. AI-EES is adapting its Major Business Strategy in 2014 -2017 to realize these improvements. Investments in commercialization, our focus on new partnerships with technology incubators and venture capital organizations as well as relationships with NRCan and COSIA is leading to a greater impact on meeting 2020 and 2030 targets.

AI-EES PERFORMANCE GRID

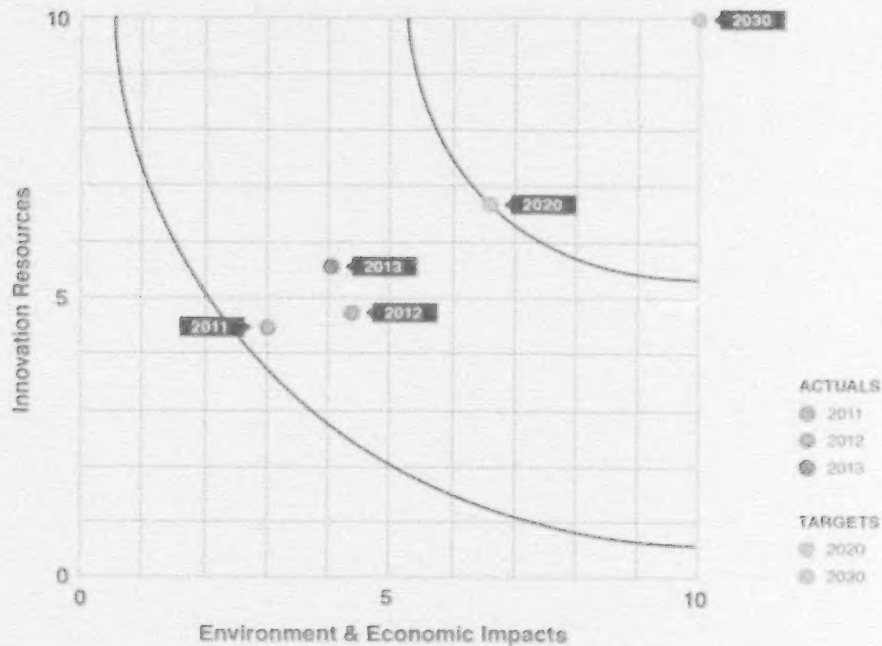


Figure 6: 2012-13 ProGrid Summary Performance Grid showing the progress that is being made to reach the long-term 2020 and 2030 goals and targets.

Technology Readiness Levels (TRL)

AI-EES evaluates projects and tracks their success by assessing their TRL relative to progress and milestones achieved (Figure 7 provides a simplified TRL). This allows AI-EES to maintain a balanced portfolio of projects along the pathway towards commercialization; keeping a number of projects entering the spectrum at the early ideas stage and developing technology transfer strategies when projects move closer to commercialization. CCEMC projects are included because AI-EES provides project evaluation and project management to ensure promising technologies are progressing toward commercialization.

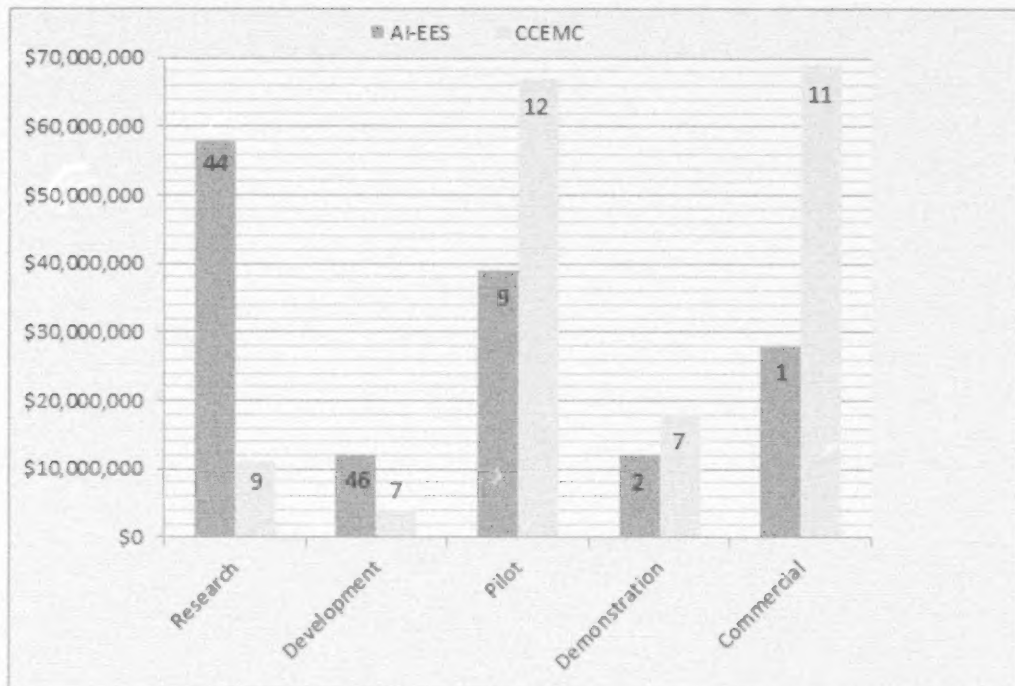


Figure 7: 2012-13 Mapping AI-EES' active projects along the innovation path. Number of projects in each level is noted on the bar.

Maintaining a Balanced Portfolio

To maintain balance, our investments in three priority areas vary year-by-year as projects progress through their life cycle, new projects begin, and others are completed.

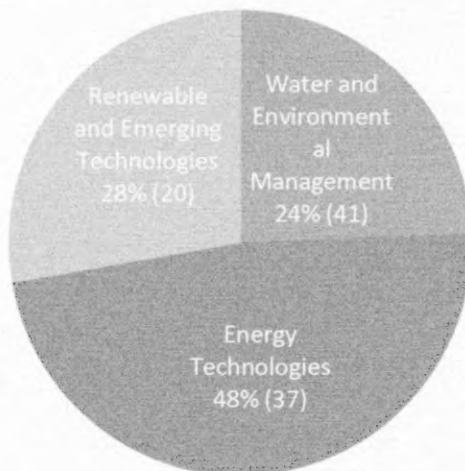


Figure 8: This chart shows the 2012 – 2013 actual results: per cent of total committed funds invested in each strategic area and the number of projects in each area (shown in brackets). The funds committed in 2012-13 total \$13.8 million.

As AI-EES develops the Advancing Clean Energy Commercialization business model in 2014-17, we anticipate there will be greater venture capital investment in Alberta. This will have impact on all three strategic areas in AI-EES.

Performance Measures	2012-13 Actual	2013-14 Target	2014-15 Target	2015-16 Target
Venture capital investment in Alberta (\$ Millions)	86.34 (2012)		126.16	131.80

(Source Innovation and Advanced Education Business Plan 2014-17)

Table 1
Three Year Budget

(thousands of dollars)

	Comparable					
	2012-13	2013-14		2014-15	2015-16	2016-17
	Actual	Budget	Forecast	Estimate	Target	Target
REVENUE						
Funding from Innovation and Advanced Education	22,073	14,385	14,385	14,385	14,385	14,385
Restricted Funds for AI Centres		1,040	1,040	2,400		
Restricted Funds for Water and Tailings		5,060	2,744	6,694	3,661	2,231
Restricted Funds for AWRI		6,145	2,895	2,781	2,535	543
Funding from other GOA Ministries		1,246	1,379	2,030	3,000	4,600
Funding from other Government Sources			160			
Industry Funding			518	940		
Investment Income	518	238	401	400	350	320
Intellectual Property Income		275	15	11	11	11
Other Revenue	2,106	273	80			
Total Revenues	24,697	28,662	23,618	29,641	23,941	22,090
EXPENSES						
Energy Technologies	9,430	8,990	3,693	7,339	6,478	651
Renewables and Emerging Technologies		4,275	543	6,437	3,928	4,890
Water and Environmental Management		3,778	2,228	4,878	5,245	2,596
Water and Tailings Grants		5,263	2,744	4,194	2,661	1,811
AWRI Research Grants	2,591	6,096	2,498	2,316	2,118	120
Total Research	12,021	28,403	11,707	25,164	20,430	10,069
Program Administration	4,237	4,111	3,618	4,213	3,923	4,027
Technical Support Services	2,702	3,351	2,351	4,157	2,913	2,903
Grand Total Expenses	18,960	35,865	17,675	33,534	27,267	16,998
Net Operating Results	5,737	(7,203)	5,943	(3,894)	(3,326)	5,092

Net Assets Beginning of Year	20,838	26,575	26,575	32,518	22,825	14,999
Add Net Operating Results	5,737	(7,203)	5,943	(3,894)	(3,326)	5,092
Less Total Projects - Applications				5,800	4,500	3,886
<i>Net Assets, End of Year, adjusted for pending applications</i>	26,575	19,372	32,518	22,825	14,999	16,204
Less Contingency Fund		5,315		6,504	4,565	3,000
Less Allowance for Wind Up Costs		1,700		1,900	1,900	1,900
Adjusted Net Assets, End of Year	26,575	12,357	32,518	14,421	8,534	11,305

Research and Innovation Priorities - Budget Allocations to Key Outcomes for 2014-17 Business Plans

Research and Innovation (RI) Priorities	Total 2014-15 Budget (\$'000)	Key Outcomes of the Alberta Research and Innovation System		
		Effective Resource and Environmental Management (\$'000)	Broadened Economic Base (\$'000)	Resilient, Healthy Communities (\$'000)
Energy Technologies	7,339	3,670	3,670	
Renewable and Emerging Resources	6,437	3,219	1,931	1,287
Water and Environmental Management	4,878	2,439	1,220	1,220
Water and Tailings Research	4,194	2,097		2,097
AWRI Research	2,316	1,158	579	579
Total	25,164	12,582	7,399	5,183